Radar Analysis Visual Suite (RAV)

Software Requirements Specification (SRS) For Display and Plot

May 20, 1998
SLR-RAV-DISP-DA

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Justification and Background. The ability to display radar data for analysis has been in need for a long time. This document attempts to capture the requirements for displaying radar data within a graphical window or via a hard copy printout. Some common terms for referring to this data may include plots, graphs, or displays. The display of graphical radar data is useful to the radar analyst when the data can be viewed or displayed on the PC, or printed, plotted, or graphed on paper as a usable hard copy. Several existing programs provide these core functionality and some may be referenced herein. Many of these programs, have not been ported to the Microsoft® Windows™ environment and those that have, do not follow the conventional standards of good graphical user interface design, ease-of-use, or functionality.

Part of the Radar Analysis Visual Suite (RAV) software design is to provide an easy to use Windows Interface, along with enhanced maintainability, standard use of Windows conventions for look-and-feel— Graphical User Interface, and to take full advantage of the multi-tasking ability of Windows. e.g. the capability to have many display windows operating at the same time. With this in mind, requirements for the next generation of Windows based radar analysis tools, should utilize to the fullest capability, the power of Windows. Thus, new requirements are needed and new features can be made available because of technology enhancements.

Additionally, close integration amongst the applications, is a requirement that can be met by the use of Windows and insightful design criteria. For example, the work done on RAV to date has implemented a common radar format into the core which allows user defined message types and additional information to be appended to the standard radar messages which can then be written to the radar recording file. One scenario is that false target information can be appended to the radar data file allowing the display of these false targets in the plot or display program in various colors or symbologies to represent the various false target categories. In order for this to occur, close integration must be a priority of the requirements and design of any plot or display program.

Purpose of the System Level Requirements

The System Level Requirements or SLR for the Display and Plot applications contain the high-level requirements for the programs. The SLR, in later draft versions is categorized into two sections: requirements for Phase I delivery and requirements for Phase II delivery. Hereafter, those two phases will be designated as P-I or P-II.

Methodology Used

The format of these requirements are based off of standard interpretation of software requirements in that they follow a generalized format, are abstract, and address the issue of “What” through identification of needs. These requirements are considered high-level and generalized. Detailed or low-level requirements may be used to facilitate design but it is more likely that a set of functional specifications will be developed from these requirements. Functional specifications are more detailed and more closely convey the “How” and any constraints or considerations. Typically, the functional specifications are worded using phrases or terms such as “must have”, “should”, or “will”. “And” and “Or” are very significant. For example, “The PPI display shall increment forward one scan by clicking on the ‘forward one scan’ button”. The reviewer is encouraged to provide

feedback in as much detail as possible, as if the reviewer was writing the functional specification, to assist in building the functional specifications.

Scope.

This document supplies information applicable to the PPI, Horizon, Display and Plot high level requirements. It does not provide information for the RAV software of which the display applications are a part.

Intended Audience

The intended audience for this specification is the user, manager, software developer, or tester, and as such is written with consideration for this diverse audience. However, there are times when an idea or concept can only be conveyed through the use of terms that software developers or radar analysts are knowledgeable in, without extensive definitions for a general audience, so that the meaning is not lost.

Conventions Used.

Unless otherwise designated, all requirements pertain to Phase I. There will not be an explicit declaration of a Phase I requirement unless there is a corresponding Phase II requirement. If there is no corresponding section in Phase I, a Phase II (high level) section will be added. When there are sections in Phase I that correspond to a Phase II requirement, the Phase II requirement will be inserted at the same level as the Phase I requirement, and the Phase I requirement will be explicitly declared.

The format of this document is in outline form. Whenever possible, Radar Analysis terms and Windows terms are *italicized* such as *runlength, terminal, enroute,* or *pop-up menu*. The users generally provide requirements and are most likely familiar with these terms with the exception of some of the Windows and Windows programming terms. Since, the majority of the radar analysis programs have been written for DOS or other operating systems, not all of the users are expected to be familiar with all Windows terms, standards, or programming conventions.

References.

TABLE 1. Reference DocumentsTitle

Title	Version
System Level Requirements (SLR) for RAV	SLR-RAV-CORE-D
BFTW SLR	SLR-RAV-BFTW-F
BFTW SRS	SRS-RAV-BFTW-D
IEEE Std 830-1993 Recommended Practice for Software Requirements Specification	IEEE STD 830-1993
Software Requirements Specification (SRS)for Display and Plot	SRS-RAV-DISP-D

1. Graphical User Interface

The graphical user interface (GUI) is an integral part of any Windows based application. This section applies to the GUI for the display and plot applications that will be developed.

1.1. Controls—Toolbar or Buttons

1.1.1. Dock-able or re-locatable. Attached or floating. Icon type representations of menu commands or keyboard shortcuts to facilitate ease-of-use.

1.1.2. Context Sensitive Controls. Enabled/Disabled dependent on current context. e.g. Play button enabled from recorded data but disabled during live data presentation. Whenever possible buttons should convey current mode; enabled or disabled. e.g. by appearing to remain depressed, raised, or grayed.

1.1.3. VCR Control type buttons. e.g. fast-forward and rewind scan buttons enhance playback capability.

1.1.4. Speed Control (see 2.3.11).

1.1.5. Balloon Help. The capability to display *balloon help*, or hints, on all toolbar buttons is desired.

1.2. Keyboard/Menu Shortcuts. *Accelerator*, Hotkey and/or *menu shortcut* capability.

1.3. Pop-Up Menus—right mouse button click accessible. Additional features, Help, etc.

1.4. Multiple Document Interface. Display windows or plots are moveable, sizeable, windows that can be tiled, cascaded, etc., as in most *MDI* Windows applications. MDI Windows are child windows that reside within a MDI parent frame window and cannot be displayed outside of the MDI parent frame. MDI allows other (in this case RAV) applications to be open concurrently on the desktop within the frame, permitting the user to navigate back and forth.

2. Display and Plot Capabilities

This section contains the requirements for the two types of display applications that are to be developed and their common requirements.

2.1. Planned Position Indicator (PPI) display. A PPI type display that is a 2-dimensional polar plot of radar data as it would appear looking from the top-down or above view of the radar. The PPI display is of the type typically used by

radar analysts and air traffic controllers with some minor differences to be detailed in this document.

2.1.1. Maximum Range. The display shall be capable of displaying targets of maximum ranges at 250, 200, 125, 60, 30, 15, 10, and 5 NMI.

2.1.2. Range Rings. The capability to display range markers to facilitate approximate position can be represented by several equally spaced concentric circles fixed and centered about the origin of the radar. These circles are commonly known as *range rings* within the radar analyst and air traffic control arena.

a) **Specification.** Range rings shall be user selectable at specified intervals of 2, 5, 10, or 25 miles regardless of the maximum range of the radar or zoomed in area. e.g. if zoomed in at less than 2 NMI, no range marks are visible. Conversely, if the maximum range of the radar is 64 NMI, and not in the zoom mode, then 0, 2, 6, 12, or 32 range marks will be visible depending on the range interval selected; None, 2, 5, 10, or 25.

2.1.3. Angular, Sector, and Tick Marks. The capability to display angular marks at TBD angle intervals or at sector mark locations will aid the analyst to approximate target azimuth at a glance. *Angular or sector marks* can be defined as extending from the radar center or PPI origin to the maximum range coverage of the radar. The capability to display *angular tick marks* which can be defined as short lines which **do not** extend from the PPI origin to the maximum range of the radar's coverage but extend from a point near the end of radar coverage to the end of radar coverage or slightly beyond.

2.1.4. Display Current Range/Azimuth. The program shall display the current range and azimuth in a status area based off of the current cursor position and update it at all times as the mouse moves.

2.2. Horizon Display. A 2-dimensional Cartesian display that plots radar data as range vs. altitude. The presentation of the data is as if viewed from a horizontal position or side view. If the range viewed is large enough, targets displayed can be seen to be affected by the curvature of the earth.

2.2.1. Grid. The capability to facilitate approximate position of aircraft can be represented by displaying a grid of equally spaced lines at appropriate range and altitude intervals. The horizon display shall be broken into user selectable range and altitude intervals that forms a grid of reference lines. Intervals are to be selectable in **TBD intervals.**

2.2.2. Display Current Range/Altitude. The program shall display the current range and altitude in a status area based off of the current cursor position and update it at all times as the mouse moves.

2.3. PPI/Horizon Common Requirements.

2.3.1. Zoom Capability. Ability to *zoom* (appear to expand) into a user selectable portion of the screen or in some increment in range, percent, or multiplier. Multiple zooms (i.e. zoom in on a zoomed area) shall be allowed although there can be some limitations as to the amount of zooms allowed due to memory or system constraints. Therefore, the program shall not allow a zoom when the area is too small.

There shall be two modes for zooming: *immediate* and *selected*. Immediate mode shall have limited capabilities of only being able to perform two actions; zoom in or zoom out. Selected zoom mode shall allow the user to zoom in via default or selectable increments and can only be enabled from a selection window (see 2.3.14.1). The selected zoom mode will have more capabilities and shall allow the user to perform actions such as target tag/lookup, pop-up menu via right mouse button click, and further zooms via immediate or selected zoom modes.

a) **Immediate Zoom Mode (Default).** The default zoom mode is Immediate. Any left-click and release of the mouse button in the area of desired zoom will cause the location of the click to be the center origin of the window and cause an immediate zoom of 100% or 2:1 ratio. Subsequent left mouse button clicks will repeat the same action. Similarly, once in the immediate zoom mode, a right click shall cause a zoom out of 50% or 1:2 ratio. To initiate other actions described in this document such as target lookup and pop-up menu accessible via right mouse button click, the Immediate Zoom mode must be temporarily disabled via a toolbar button, keyboard (Ctrl-Left Mouse Button click), or menu action.

b) **Selected Zoom Mode.** The Selected Zoom mode shall be enabled via one of three actions; toolbar button, menu, or via the pop-up menu from a rectangular selection region (see 2.3.14.1). Other actions described in this document such as target lookup and pop-up menu accessible via right mouse button click, shall be accessible in this zoom mode.

2.3.2. Print Capability. Ability to print display presentation re-scaled for the user selected printer with automatic color to monochrome conversion to enhance graphic output.

2.3.3. Symbols. Targets, tracks, and future visual outputs can be represented through the use of symbols. Numbers, and special characters are also used as symbols. *Symbols* are the typical representation of aircraft or radar data displayed in existing programs such as RRAP, PLOTASR, and RTADS. For Phase II the capability to switch between opaque and transparent modes shall be provided.

2.3.3.1.1. Opaque (P-I). The symbols should be capable of being displayed opaque where the background or fill area of the symbols is not transparent. The Opaque mode is useful in cases where the foreground color is similar to the background color or where transparency may not be desirable.

2.3.3.1.2. Transparent (P-II). The symbols shall be capable of being displayed transparently so that any underlying background or bitmap can still show through

2.3.3.1.3. Symbols. Geometric shapes and characters such as rectangles, triangles, *, +, and • (dot) are known as symbols and are used to graphically represent the location and/or the type of target displayed.

2.3.3.1.3.1. Colors. The color of the symbol can designate the various types of targets.

a) **Specifications.** The colors of the symbols are to be: yellow for beacon-only, green for radar-reinforced, blue for radar only, white for duplicate, light-blue for invalid Mode C, and cyan for RTQC or PE.

2.3.3.1.4. Numbers. The ability to display alpha-numerics that symbolize the direction of travel and scan of the currently represented target. Numbers from the last digit of the scan can represent the order sequence of scans while tracing visual track history. The color of the symbol can represent the type of target i.e. radar-reinforced.

a) **Specifications.** The numbers and alpha characters are to be designated as follows: The scan numbers that are evenly divisible by 10 shall be represented by Alpha characters starting with ‘A’ for scan 10, ‘B’ for scan 20, etc., all the way through the letters of the alphabet. At rollover, which occurs at scan 270, the Alpha characters shall start over again with the letter designation, ‘A’, ‘B’, and so on. Numeric digits 1-9 shall represent the scans that fall in between the 10 scan even intervals defined by the alpha characters. e.g. scans 8, 9, and 10 shall be represented as ‘8’, ‘9’, and ‘A’.

2.3.3.1.5. Trails. The capability to display a set of symbol trails represented by non-erasure of the previous scan’s symbol or an erase and display of a dot type symbol to represent targets from previous scans.

2.3.3.1.6. Registration – Actual Target vs. Symbol Location. The location of the symbol shall be at the location of the actual target by placement of the symbol at its vertical and horizontal center alignments. For example, a symbol such as a square shall be placed centered around the actual range and reported azimuth of the target. For Alpha-Numeric symbols or digits, the character shall be centered in both its horizontal and vertical alignments on the reported target's location.

2.3.4. Leader Lines (P-I). The display of a "leader line" from the symbol to an approximate position of the data block shall be drawn. The direction of the leader line shall be user selectable in any azimuth direction in 30-degree increments.

2.3.4.1. Auto Offset Leader Lines (P-II). The program shall automatically determine if other leader lines in the area overlap and intelligently move the leader line into an area where overlap is minimized or eliminated.

2.3.5. Target Lookup, History, and Tracking. The ability to provide target information or attributes on targets in current or previous scans shall be provided.

Trails, as described in section 2.3.3.1.4 above, are the visual representation of history. History information is visually represented by symbols or trails as well as data blocks, section 2.3.11.1, while the actual information is accessed via a lookup process or through some method of limited tracking. Some limited tracking or an indexing method may be performed to lookup attributes on targets.

2.3.6. Filtering. Individual tracks, geographical radar coverage areas, message types, time, or other types of filtering may be desired. It is assumed that the current *filters* developed under RAV will be used and that the implementation of the filters at various levels such as at the display object level, or at the global file object level, is the main issue here.

2.3.7. Multi-Sensor Stereo or Mosaic (P-II). It is believed that requirement 1.4, Multiple Document Interface, shall allow the user to view multiple radar sensors simultaneously. However, a further need for a *Mosaic* capability, also known as *stereo*, which can be defined as the ability to display multiple radars' coverage areas into a single Window, will allow the analyst to see overlapped radar coverage areas from adjoining or adjacent radars. Additional requirements utilizing latitude and longitude conversion algorithms will be defined to aid in analyzing *registration* problems between adjacent overlapped radar coverage areas.

2.3.8. Scrolling/Panning. An ability to pan or scroll a zoomed or non-zoomed (normal) area is necessary especially when windows may be smaller than the actual area to be displayed.

2.3.9. Center/Offsetting. When in the *zoomed or normal modes*, it is desirable that the center of the display window not necessarily be always fixed to the normal graphical or radar center. The capability to display data from a different origin, in respect to the radar's center, can be considered an *offset* or offsetting type display of data. It may be desirable to provide a homing mode whereby the user can immediately return to the normal radar center origin mode.

2.3.10. Status Information. The capability to display information which conveys status to the user to aid in *navigation* of the radar data file or provide useful information at that point in time within the display of *recorded* or *live* radar data. For example, an analyst will have the need to know what scan of the radar file is being displayed as well as the time, what filters may be enabled, what channels or ports are active, etc.

2.3.10.1. Data Blocks. Several target attributes as two or three lines of text, have traditionally been displayed on air traffic controllers' display screens. Normally, this includes range, azimuth, altitude, and Mode 3/A beacon code.

2.3.10.1.1. Opaque (P-I). Reference 2.3.3.1.1.

2.3.10.1.2. Transparency (P-II). Reference 2.3.3.1.2.

2.3.10.1.3. Specifications. There are two types of data block description modes: terse or verbose. For *terse* mode the data block shall display an abbreviated formatted display of target attributes user selectable but limited to three or four attributes. The defaults for terse mode if user configured shall be beacon code and altitude. For v*erbose* mode the data block display shall provide more user selectable attributes comprised of up to all target attributes.

2.3.10.1.3.1. Inputs. The inputs shall be user selectable and available as an external interface in the form of a GUI. The inputs shall be an input dialog with selections in the terse mode of up to 4 target attributes while listing all available attributes from the typical radar beacon message. For verbose mode, the selections shall be limited up to the maximum amount of available attributes from the typical radar beacon message. It is realized that selection of all available attributes will clutter the display of targets and data blocks, perhaps significantly, but it will be up to the user to decide if this is desirable.

2.3.10.1.3.2. Outputs. The outputs are to the graphical Window of the display in the form of a terse or verbose data block (2.3.9.1.3 above). The data block shall consist of multiple abbreviated lines of display. The abbreviations are designated as follows: For Mode C and Mode C validity the attributes shall be displayed as xxxxY where xxxx is the Mode C beacon code and Y is the validity of the target as 'V' for valid ' ' (blank) if invalid. The Mode 3/A beacon code and Mode 3/A validity shall be displayed similarly as XXXXy where XXXX is the 4 digit Mode 3/A beacon code and y is the validity of the code as a single character 'V' or ' ' (blank) if invalid.

2.3.10.1.3.3. Location. The size and direction of the leader line extending from the target will effect the location of the data block. However, the data block's bottom row of text will be offset from the target at the end of the leader line by no more than 5 pixels. The data block shall be above the leader line when the leader line extends in the 0-90° quadrant and when in the 270-360° quadrant. When the leader line is extended in the 90-270° quadrant, then the data block's top row of text shall be within 5 pixels of extent from the leader line.

2.3.10.1.4. Action. The display of the data block shall be enabled via the action of a single mouse click on or near the symbol.

2.3.10.2. Time and Scan. The capability to display the scan currently being presented as well as the time at the start of the scan is needed.

2.3.10.2.1. Opaque (P-I). Reference 2.3.3.1.1.

2.3.10.2.2. Transparency (P-II). Reference 2.3.3.1.2.

2.3.10.2.3. Specification. The program shall display the time and scan as hh:mm:ss.f/scan# in the upper portion of the display centered at the northmark or 0 degree location when in the PPI display. Where hh = 2 digit hour, mm = 2 digit minute, ss = 2 digit second, and f = the decimal floating point fractional part of the time up to the 3rd precision. The time shall be the time of the scan marker message for that scan. For the horizon display, the time and scan shall be centered at the top of the window.

2.3.10.3. Channel or Port Activity (P-II). The capability to visually represent the *channel* or *port activity* of data (through the use of LED or other type of controls) such as the incoming radar data for a particular channel on an MX-6A board, aids the analyst in determining if live radar data is enabled and received. Other considerations may

include intermittent error activity. e.g. red flashing LEDs for parity errors or to indicate alarm conditions extracted from status messages.

2.3.10.4. Statistical Information. Information such as the percent of *radar reinforced* can be made available on the display window, a separate pane of a *multi-pane or splitter* window similar to that used in cc:Mail or Windows Explorer, or via a pop-up window. Statistics for targets counts since the beginning of the file or start of the display shall be provided for radar only, radar reinforced beacon, beacon only, radar correlated search, and radar uncorrelated search messages. Computed statistics such as radar reinforced or blip-scan rate shall also be provided.

2.3.10.5. Filter Status (P-I or P-II?). The capability to see a graphical representation of *Include filter* types for messages can be made available on the graphic display or via *pop-up* window. If this capability can be provided using the existing RAV core filters dialog then this shall be a P-I requirement. Otherwise, it is a P-II requirement.

2.3.10.6. User Mode Information. The capability to display information such as the mode the user is currently in. e.g. the user has filters enabled, is in Zoom mode, etc. This requirement is closely related to requirement 1.1. (buttons, button states, menu states) and may in fact overlap or be redundant.

2.3.11. Navigation. The capability to navigate forward or reverse, one, all, multiple non-consecutive, consecutive or a range of scans throughout a radar data file is needed. Non-consecutive movement e.g. scans 7, 12, and 20, allows the analyst to look at specific scans where anomalies may have occurred without having to display scans in between. This has the effect of snapshot or sample intervals.

2.3.12. Speed Control. The ability to control the speed of the display presentation will be useful during *Playback* mode. Possible considerations could include Normal or 1X (actual radar scan rate), any multiplier thereof, or maximum.

2.3.13. Various Selectable Inputs. The capability for the displays to receive data from various inputs such as from memory, recorded data file, port such as MX-6A, LAN, GPS, etc., is needed. The addition of port data will require that all data be converted to the RAV messaging format. Design considerations should include an independence of input types with focus applied to presentation and display of the data.

2.3.13.1. Real Time Display (P-II). The capability to display data real-time from a given port such as an MX-6A card.

2.3.13.2. Recorded Data Display (P-I) (*Playback)***.** The capability to display recorded data that resides on disk. This capability is generally referred to as *Playback.*

2.3.14. Non-Aircraft Graphics. The capabilities to display weather data, text, map data, vector and bitmap graphics.

2.3.14.1. Vector Graphics. The capability to display vector graphics, draw lines based off of point data.

2.3.14.1.1. Weather Data (P-II). The capability to display weather data as a graphical representation in vectorized or polygon graphics that could possibly be shade filled to represent various weather data intensities or levels.

2.3.14.1.2. Map Data (P-II). The capability to display maps as vectorized graphics when given an array of points to draw lines.

2.3.14.1.3. Text (P-I). The ability to display text at a specified location given a set of points.

2.3.14.1.3.1. Opaque (P-I). Reference requirement 2.3.3.1.1.

2.3.14.1.3.2. Transparent (P-II). Reference requirement 2.3.3.1.2.

2.3.14.2. Bitmap Graphics (P-II). The capability to display bitmap graphic files. Bitmap graphics are a Windows standard and are used as Windows wallpaper and other applications. The user may desire to display an aerial or other type of photograph (properly scaled, of course) and plot radar targets on it. If bitmap graphics are scaled, the quality may be poor. e.g. a small bitmap re-scaled to fit a full screen window will appear to be very blocky and almost unusable.

2.3.15. Selecting or Picking. The capability to select a region, or graphic object.

2.3.15.1. Selecting. The capability to *select* a rectangular region (known as *rubber banding*) on the display using a mouse. Typically performed by positioning the mouse at the anticipated upper-left corner of a rectangular region, clicking the left button down and while continuing to hold the left button down (also known as dragging) a bordered rectangle appears onscreen that sizes dynamically depending on the position of the mouse. Some action will occur after the selection of the rectangular region. One possible option is to filter all targets within that geographical area that the selection represents.

2.3.15.2. Picking. The capability to select a graphic object such as a symbol. The analyst will have a need to *pick* a target symbol in order to display a data block or additional target attribute information.

2.3.16. Integration Requirements. The need for carefully planned integration requirements has been expressed in the Justification and Background section of this document.

2.3.16.1. False Target Recognition. The capability to display targets that have already been identified as false by Beacon False Target Analysis for Windows (BFTW) in various colors or symbols to represent the category of false target identified. The RAV software will have the capability to append false target information to target messages that have been declared false or part of a real-false pair.

2.3.16.2. Filtering. After a rectangular region has been selected through *rubber banding* or a target has been *picked*, the target(s) or the selection area itself can then be used as a filter. This filter can in turn be used as input data into another RAV application program.

2.3.16.2.1. Display (output) Filter by Type. The capability to filter by message type or message attribute i.e. radar-reinforced or Mode 3/A code from being displayed. The filter object shall be of the type used in the RAV core.

2.3.16.2.2. Integrated Filters. The display program shall provide the RAV core compatible filter(s) to be passed to a RAV application program for input or launching as described in the next section 2.3.17.3.

2.3.16.2.3. RAV Application Program Launching. The capability to launch RAV application programs. For example, after selecting a region within *PPI*, the user should be able to launch the *Message Viewer* program (probably from right mouse clicking, activating a *pop-up* menu, and selecting the *Message Viewer* program).

2.3.16.2.3.1. (P-I) Message Viewer, PPI, or Horizon. The program shall provide a capability to launch the Message Viewer from the PPI or Horizon programs by passing a filter provided by the PPI or Horizon application. The PPI and Horizon programs shall also be capable of launching each other i.e. PPI launches Horizon or vice-versa by passing a filter provided by the PPI or Horizon application. There is **no** requirement for the Message Viewer to launch either the PPI or Horizon applications and is beyond the scope of this document.

2.3.16.2.3.2. Other Programs (P-II). The program shall provide a capability to launch other programs such from *filtering* criteria, previously *selected* or *picked*.

2.3.16.3. Recording Control (P-II). While it has already been decided that recording of radar data will be accomplished by another RAV application program, the control of the recording such as Start or Stop, is needed.